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ABSTRACT

The relative contribution of students' capability to perceive structural versus surface similarity on their motivation transfer was studied. It was hypothesized that surface similarity would lead to greater transfer of self-efficacy among tasks due to its readily perceptible nature. More specifically, it was hypothesized that the perception of structural and surface similarity would affect the degree of similarity perceived in the problem pairs, which, in turn, would directly influence the degree of self-efficacy transfer. Participants were 588 students from 4 Los Angeles (California) high schools. Eight pairs were constructed for comparison from four problems in arithmetic-progression, algebra and four constant-acceleration problems in physics. Students were asked to relate their self-efficacy for solving each of the problems and to rate the similarity of the problems and report the reasons similarity existed. Results support the idea that surface similarity among tasks exercises greater influence on students' perceptions and on their transfer of motivation, at least in the initial stage. Perception of similarity among tasks rooted in surface-level characteristics might not help students solve problems, but it can help produce confident learners who persist in the face of difficulties. (Contains one table, five references, and two figures.) (SLD)

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ED 411 260

Running Head: TYPES OF SIMILARITY ON MOTIVATION TRANSFER

Effects of Structural Versus Surface Similarity on Transfer of Motivation

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The existing literature on transfer of learning documents evidence pointing to the importance of learner's capability to perceive structural similarity. Gick and Holyoak (1980), in their series of experiments on analogical reasoning, for example, reported that the participants in their study who were able to discern structural similarity of the given problem to the previous learned example were also able to apply their retrieved knowledge to solve the problem situated in a novel context. While there are many studies reporting the superiority or advantages of attending to structural properties (e.g., Chi, Feltovich, & Holyoak, 1981), it is difficult to find a study that demonstrates any harmful effect of perceiving surface similarity on transfer of learning. In fact, Gick and Holyoak (1987) suggested that providing learners with examples that share salient surface resemblance often helps initial learning, leading to a discovery of the structural parallelism that might go unnoticed otherwise.

There is no doubt that detecting structural similarity between a transfer and an original learning task is an important, and even a necessary, condition to ensure successful knowledge transfer. Unfortunately, as novices in many fields, students are not particularly adept at immediate recognition of structural features often embedded in a given problem. Bassok and Holyoak (1989, Experiment 1), for instance, explicitly trained students with either arithmetic-progression problems in algebra or constant-acceleration problems in physics and found that only 10 percent of those successfully trained with physics problems applied their newly acquired knowledge to solve algebra problems that shared the same structural components.

Compared to the difficulty students seem to encounter in figuring out structural attributes, their perception appears to be relatively easily swayed by surface features of a

task. Salomon's study (1984) illustrates this point. One-hundred twenty-four sixth graders were asked to rate their perceptions of TV and print as well as their perceived efficacy in learning from these two sources. A week later, they were presented with learning materials either as a silent film on TV or as a printed text. Caution was taken to ensure that both media conveyed comparable information. He found that TV was generally perceived as an easy medium compared to print and that children in the TV group reported higher efficacy toward successful learning. Interestingly, such over-confidence led to the reduced amount of effort expended in actual learning. Considering that the two media required digesting equivalent learning material, it can be taken as evidence pointing to the role played by surface elements of a task, namely, a delivery medium, on student motivation.

The present study is an attempt to compare the relative contribution of students' capability to perceive structural versus surface similarity on their motivation transfer. A hypothesis was made that surface similarity would lead to greater transfer of self-efficacy among tasks due to its readily perceptible nature. More specifically, it was hypothesized that perception of structural and surface similarity would affect the degree of similarity perceived in the problem pairs, which, in turn, would directly influence the degree of self-efficacy transfer. When there exists a large body of evidence all pointing to the potency of students' efficacy perception that promotes persistence in the face of obstacles, it would also be important to figure out what factors are conducive to successful transfer of those perceptions.

Method and Procedures

588 students from 4 high schools in the greater Los Angeles area participated in the study. Eight problems were adopted from Bassok and Holyoak's study (1989, Experiment 1) for the purpose of the present investigation. Four of them were arithmetic-progression problems in algebra and the other four were constant-acceleration problems in physics. The two groups of problems shared all the structural elements necessary for their correct solution.

A total of eight pairs was constructed for comparison out of the eight problems. Problems in four of the pairs were structurally similar although they bore no distinctive surface similarity to each other. Knowledge of one equation either as arithmetic-progression or as constant-acceleration should enable one to solve both of the problems. Problems in the other four pairs shared salient surface similarity. Features of the problems irrelevant for solution paths were modified in order to make the problems in each pair look more similar to each other at the surface level.

Problems were presented to students through an overhead projector. Each of the two problems in a given pair was first presented separately for approximately 20 to 40 seconds. At this time, students were asked to report their self-efficacy for solving each of the problems on a scale ranging from 0 (not sure) to 100 (real sure). Both problems in a given pair were then presented together for another 20 seconds. Students were told, first, to rate the similarity between the two problems on a scale ranging from 1 (not similar at all) to 7 (very much similar) and, second, to report their reason(s) for the perceived similarity or dissimilarity. Four choices were provided for selection; (a) they require similar solution methods, (b) both of them involve money (varied across pairs), (c) you can solve them by using the same equation, and (d) both of them are algebra (or physics)

problems. They were also encouraged to state in the blank provided any other reasons not listed. Among the four reasons, (a) and (c) were coded as structural orientation whereas (b) and (d) were coded as surface-level similarity.

A difference between students' efficacy ratings for each of the two problems in the pairs was calculated and taken as a variable representing the degree of efficacy transfer between the two. Correlational and path analyses were run to test the hypothesized relationship among selected variables.

Results and Discussion

Among the four reasons provided, students selected the choice (a), that they required similar solution methods, most often as a factor that influenced their similarity perception ($\underline{M}$ = 53.0%, $\underline{Mdn}$ = 52.1%). It was closely followed by the choice (b), that they shared a salient surface characteristics (e.g., money), which varied across pairs ($\underline{M}$ = 48.7%, $\underline{Mdn}$ = 46.6%). Therefore, it appears that most students realized that the set of problems shared at least some common structural ground. However, such perception did not lead to the recognition of structural particulars required to solve the problems as reflected in the lowest percentages of students selecting the choice (c), that they involved solving for the same equation, as a reason for the reported similarity ($\underline{M}$ = 29.6%, $\underline{Mdn}$ = 30.5%).

Additional analyses were run to find out whether students picked more structural reasons in structural pairs and more surface reasons in surface pairs. Chi-square tests revealed that significantly more students indeed selected more or equal number of structural reasons to that of surface reasons in structural pairs, $\chi^2 = 66.36$ ($\underline{df} = 1$, $\underline{N} = 544$), $\underline{p} < .05$. The opposite pattern was obtained in surface pairs such that significantly

more students selected more or equal number of surface reasons for the reported similarity, $\chi^2 = 13.16$ ($df = 1$, $N = 549$), $p < .05$.

To test the effects of structural versus surface similarity perception on the degree of perceived similarity and of self-efficacy transfer within the pairs, correlational analyses were run followed by path analyses. When the total sample was included in the analysis ($N = 430$), the relationships among the variables were low to moderate ($r = .36$ between structural and surface similarity perception, $r = .14$ between surface similarity perception and the degree of perceived similarity, and $r = -.17$ between the degree of perceived similarity and the degree of self-efficacy transfer, all $ps < .05$; $r = -.06$ between structural similarity perception and the degree of perceived similarity, $p > .05$). The negative relationship exhibited by the degree of self-efficacy transfer with the other variables was as expected since it was operationalized as the difference between efficacy ratings for each of the two problems in a given pair. The difference between efficacy ratings should decrease as the similarity ratings for each pair increases in order not to reject the hypothesis that self-efficacy transfer depends, in part, on the degree of perceived similarity between problems.

The relationships became stronger when the analyses included only those who had previously taken at least one semester of algebra and physics ($n = 135$; $r = .32$ between structural and surface similarity perception, $r = -.17$ between structural similarity perception and the degree of perceived similarity, and $r = .26$ between surface similarity perception and the degree of perceived similarity, all $ps < .05$). As hypothesized, the self-efficacy transfer demonstrated a significant negative relationship both with surface similarity perception ($r = -.19$, $p < .05$) and the degree of perceived

similarity ($r = -.27$, $p < .05$). Therefore, students who reported having perceived more surface similarity between the problems gave higher overall similarity ratings as well as felt comparably efficacious toward the problems included in each pair. Structural perception of similarity failed to display a significant relationship with the degree of efficacy transfer.

A path model was run that hypothesized direct effects of (1) algebra and physics grade on surface and structural similarity perception, (2) of algebra grade, physics grade, surface similarity, and structural similarity on the degree of perceived similarity, and (3) of algebra grade, physics grade, surface similarity, structural similarity, and the degree of perceived similarity on the degree of self-efficacy transfer.

Algebra grade emerged as the only significant predictor of surface as well as structural similarity perception, $F = 5.21$ (2, 132) and 5.92 (2, 132), respectively, both ps $< .05$ ($R = .27$ and .29, $\beta = .19$ and .30, respectively). Algebra grade, surface similarity, and structural similarity perception all significantly and directly influenced the degree of perceived similarity, $F = 7.10$ (4, 130), $p < .05$ ($R = .42$, $\beta = .16$, .30, and -.32, respectively). However, as the students selected more structural reasons for their similarity perception, they reported decreased level of overall perceived similarity between the problems. Surface similarity perception, on the contrary, remained as a positive predictor of the degree of perceived similarity. The degree of perceived similarity, in turn, exerted a direct effect on the degree of self-efficacy transfer in the hypothesized direction, $F = 2.99$ (5, 129), $p < .05$ ($R = .32$, $\beta = -.22$).

The results from the present study provide support for the claim that it is surface similarity among tasks that exercises greater influence on students' perception and on

their transfer of motivation, at least in its initial stage. Perception of similarity among tasks rooted in surface-level characteristics might not help students solve the problems, but it can help produce confident learners who will try steadfastly in the face of difficulties.

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Table 1

Correlations Among Variables Related to Perceived Similarity and Self-Efficacy Generalization for the Selected Sample

	1	2	3	4	5	6
1. Estimated grade in algebra	--					
2. Estimated grade in physics	.43***	--				
3. Structural reason	.29**	.10	--			
4. Surface reason	.24**	.21*	.32***	--		
5. Perceived similarity	.18*	.19*	-.17*	.26**	--	
6. Self-efficacy generalization	-.17	-.03	-.01	-.19*	-.27**	--

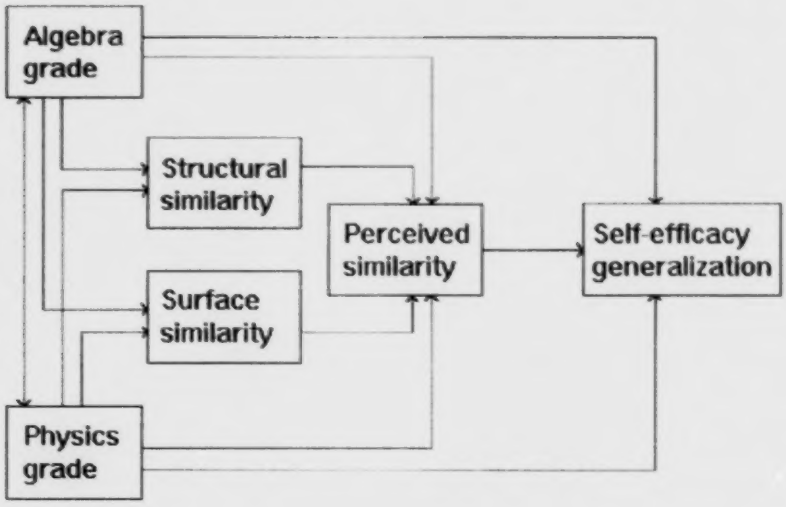
Note. N = 135. Only those who had previously taken at least one semester of algebra and physics were included in the analysis.

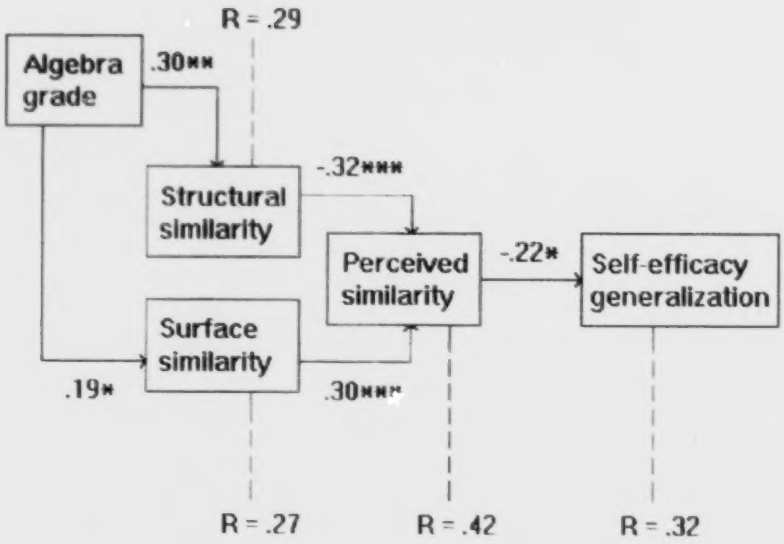
* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure Captions

Figure 1. A hypothesized path model of perceived similarity and self-efficacy generalization.

Figure 2. A final path model of perceived similarity and self-efficacy generalization. * $p < .05$. ** $p < .01$. *** $p < .001$.


Algebra grade
Structural similarity
Surface similarity
Perceived similarity
Self-efficacy generalization
Physics grade


R = .29
Algebra grade
.30**
-.32***
Structural similarity
Perceived similarity
-.22*
Self-efficacy generalization
Surface similarity
.19*
.30***
R = .27
R = .42
R = .32